9 QUALITY ASSURANCE PROCEDURES

Random Numbers

Design Mix Formula

Lot/Sublot -- QC/QA HMA and SMA

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Adjustment Period -- QC/QA HMA and SMA

Mixture Acceptance

QC/QA HMA
HMA
SMA

Pay Factors -- QC/QA HMA

Mixture
Density

Mix Appeal -- QC/QA HMA

Adjustment Quantity -- QC/QA HMA

Adjustment Quantity -- SMA

Mixture Adjustment Factor

CHAPTER NINE:
QUALITY ASSURANCE PROCEDURES

The acceptance criteria for QC/QA HMA set out in the Quality Assurance Specifications are based on binder content, air voids @ N_{des}, VMA @ N_{des}, density and smoothness. The Specifications establish controls for temperature of the mixture, testing of aggregates for quality, and testing of binder. The acceptance criteria for HMA mixtures are based on binder content and air voids. The acceptance criteria for SMA mixtures are binder content and gradation.

This section includes the procedures for obtaining acceptance samples, minimum requirements for mixture properties in accordance with Sections **401** (QC/QA HMA)**, 402** (HMA)**,** and **410** (SMA), and the procedures for determining pay factors.

RANDOM NUMBERS

Sampling for mixture tests is done on a random basis using **ITM 802**. A table of Random Numbers, as shown in Figure 5-1, is used to determine the random quantity or random location. The numbers occur in this table without aim or reason and are in no particular sequence. Therefore, samples obtained by the use of this table are truly random or chance, and eliminate any bias in obtaining samples.

To use the random number table to determine the random ton to sample, select without looking one block in the table. After selecting the block, the top left number in the block is the first random number used. This number is the beginning number. Proceed down the column for additional numbers and proceed to the top of the next column on the right when the bottom of the column is reached. When the bottom of the last column on the right is reached, proceed to the top of the column at the left. If all numbers in the table are used, select a new starting number and proceed in the same manner.

To use this table to determine the location of the pavement sample, again select a block in the table and start with the top left number. This number is used to determine the test site station. The adjacent number within the block is used to determine the transverse distance to the random site. Proceed down by pairs until the bottom numbers are reached and proceed to the adjacent top block to the right, if available. When the bottom pair of numbers on the right are reached, proceed to the top block on the left in the table.

0.576	0.730	0.430	0.754	0.271	0.870	0.732	0.721	0.998	0.239
0.892	0.948	0.858	0.025	0.935	0.114	0.153	0.508	0.749	0.291
0.669	0.726	0.501	0.402	0.231	0.505	0.009	0.420	0.517	0.858
0.609	0.482	0.809	0.140	0.396	0.025	0.937	0.310	0.253	0.761
0.971	0.824	0.902	0.470	0.997	0.392	0.892	0.957	0.040	0.463
0.053	0.899	0.554	0.627	0.427	0.760	0.470	0.040	0.904	0.993
0.810	0.159	0.225	0.163	0.549	0.405	0.285	0.542	0.231	0.919
0.081	0.277	0.035	0.039	0.860	0.507	0.081	0.538	0.986	0.501
0.982	0.468	0.334	0.921	0.690	0.806	0.879	0.414	0.106	0.031
0.095	0.801	0.576	0.417	0.251	0.884	0.522	0.235	0.389	0.222
0.509	0.025	0.794	0.850	0.917	0.887	0.751	0.608	0.698	0.683
0.371	0.059	0.164	0.838	0.289	0.169	0.569	0.977	0.796	0.996
0.165	0.996	0.356	0.375	0.654	0.979	0.815	0.592	0.348	0.743
0.477	0.535	0.137	0.155	0.767	0.187	0.579	0.787	0.358	0.595
0.788	0.101	0.434	0.638	0.021	0.894	0.324	0.871	0.698	0.539
0.566	0.815	0.622	0.548	0.947	0.169	0.817	0.472	0.864	0.466
0.901	0.342	0.873	0.964	0.942	0.985	0.123	0.086	0.335	0.212
0.470	0.682	0.412	0.064	0.150	0.962	0.925	0.355	0.909	0.019
0.068	0.242	0.777	0.356	0.195	0.313	0.396	0.460	0.740	0.247
0.874	0.420	0.127	0.284	0.448	0.215	0.833	0.652	0.701	0.326
0.897	0.877	0.209	0.862	0.428	0.117	0.100	0.259	0.425	0.284
0.876	0.969	0.109	0.843	0.759	0.239	0.890	0.317	0.428	0.802
0.190	0.696	0.757	0.283	0.777	0.491	0.523	0.665	0.919	0.246
0.341	0.688	0.587	0.908	0.865	0.333	0.928	0.404	0.892	0.696
0.846	0.355	0.831	0.218	0.945	0.364	0.673	0.305	0.195	0.887
0.882	0.227	0.552	0.077	0.454	0.731	0.716	0.265	0.058	0.075
0.464	0.658	0.629	0.269	0.069	0.998	0.917	0.217	0.220	0.659
0.123	0.791	0.503	0.447	0.659	0.463	0.994	0.307	0.631	0.422
0.116	0.120	0.721	0.137	0.263	0.176	0.798	0.879	0.432	0.391
0.836	0.206	0.914	0.574	0.870	0.390	0.104	0.755	0.082	0.939
0.636	0.195	0.614	0.486	0.629	0.663	0.619	0.007	0.296	0.456
0.630	0.673	0.665	0.666	0.399	0.592	0.441	0.649	0.270	0.612
0.804	0.112	0.331	0.606	0.551	0.928	0.830	0.841	0.702	0.183
0.360	0.193	0.181	0.399	0.564	0.772	0.890	0.062	0.919	0.875
0.183	0.651	0.157	0.150	0.800	0.875	0.205	0.446	0.648	0.685

Figure 9-1. Random Numbers

DESIGN MIX FORMULA

The Producer is required to submit for the Engineer's approval a Design Mix Formula (DMF) for each mixture. This information is recorded in a format acceptable to the Engineer. TD-451 is one format that has been used for this purpose (Figure 5-2). INDOT is required to have a signed copy of the DMF prior to production of any mixture.

LOT/SUBLOT -- QC/QA HMA and SMA

Quality Assurance Specifications consider a lot as 4000 t of Base or Intermediate QC/QA HMA, and 2400 t of Surface QC/QA HMA or SMA. The lots are divided into four sublots of equal tons. For Base and Intermediate QC/QA HMA therefore, a sublot is 1000 t, and for Surface QC/QA HMA or SMA, a sublot is 600 t. Partial sublots of 100 t or less are added to the previous sublot. Partial sublots greater than 100 t constitute a full sublot.

ACCEPTANCE SAMPLES

Sampling of mixture for acceptance is made from the pavement in accordance with **ITM 580**. INDOT determines the random site and the Contractor obtains the samples under INDOT supervision.

A specific ton in each sublot is selected and the mixture from the truck containing that ton is sampled. This truck is determined by checking the weigh tickets. An example of how to determine what ton is to be sampled is indicated on form TD 452 (Figure 5-3). These random tons are not shown to the Contractor so that there is no possible influence on the construction operations.

Once the truck that contains the random ton is identified, the approximate total length of mixture that the truck places is determined by knowing the weight of the truck, the paving width, and the quantity placed. When placing variable depth, such as a crown correction, the average depth is used. The following relationship is used to calculate this approximate length that a truck would place.

$$\text{Length of Load (Nearest Foot)} = \frac{\text{Load Weight (t)}}{\text{Avg. Planned Quantity } (\text{lb/yd}^2) \times \text{Width of Paving (ft)}} \times 18000$$

INDIANA DEPARTMENT OF TRANSPORTATION
MATERIALS AND TESTS DIVISION
HMA DMF/JMF per 401/402

HMA PRODUCER :	J. Wooden Construction
PLANT LOCATION :	Indianapolis
CERTIFIED PLANT NUMBER:	3550
APPROVED DESIGN LAB :	3091

CONTRACT	ROAD	D	401/402	DTE Approval	DATE
R-26987	US 36	G	402	Michael Nelson	06/24/07
R-27865	SR44	G	402	Michael Nelson	06/24/07
R-27786	SR 267	C	401/402	Kurt Sommer	07/12/07

MATERIALS (Agg. Size/ Source/ Q-Number/ Quality/ Ledges/ %)
#8 (38%), #11 (10%) & #12 (15%) Stone
Hanson, S. Harding St. (2312) Ledges 24-27
#24 Natural Sand (10%) Hanson, S. Harding (2312)
Coarse RAP (25%) Plantsite
Baghouse Fines (2%) Plantsite
PG BINDER (Source/ Grade)
58-28 (3.1%)
OTHER ADDITIVES (Source/Type/Rate)

DMF number (401 only)	073411651D
DMF number (402 only)	073412651D
All applic. 401 ESAL Categories	2
All applicable 402 Types	A, B
PG-High Temp.Grade (Equivalent)	64
Mixture course	Intermediate
Mixture designation	19.0 mm
Maximum particle size	25.0 mm

	Spec	Mass	Volume
%Pass 37.5 mm		100.0	NA
%Pass 25.0 mm	100.0	100.0	NA
%Pass 19.0 mm	90-100	96.3	NA
%Pass 12.5 mm	<90	78.3	NA
%Pass 9.5 mm		67.2	NA
%Pass 4.75 mm		41.8	NA
%Pass 2.36 mm	23.0-49.0	25.8	NA
%Pass 1.18 mm		19.5	NA
% Pass 600 µm		14.5	NA
% Pass 300 µm		9.1	NA
% Pass 150 µm		6.3	NA
% Pass 75 µm	2.0-8.0	5.5	NA

Aggregate blend Gsb	2.671
Mix temp. plant min. °C (°F)	135/275
Mix temp. plant max. °C (°F)	160/320
Mix compaction temp.lab°C(°F)	150/300

* Note - Written request required, submit w / DMF

RAP in mixture, %	25.0
RAP binder, extracted, %	4.3
Ignition oven test temp., °C (°F)	538 C
Ignition oven calibration factor	0.62
Ignition oven number	
Binder, ignition (actual), %	4.2
Binder, extracted, %	3.9
Extraction required? Yes* or No	No
Binder, calculated effective, %	3.9
Gyrations Nini / Ndes / Nmax	7 / **75** / 115
Mass gyratory pill @ Ndes, g	4750
Gmm	2.52
Gmm w/ dry back? Yes or No	No
Gmm % @ Nini and Nmax	86.0 / 97.4
Gmb @ Ndes	2.419
Air Voids @ Ndes, %	4.0
VMA @ Ndes, %	13.2
VFA @ Ndes, %	70
Coarse agg. ang. 1 & 2 face, %	100 / 100
Fine aggregate angularity	41
Sand equivalency	89.0
Dust/calculated effective binder	1.4
Tensile strength ratio, %	80.6
Draindown, % (SMA or OG only)	NA
Date Ignition oven samples submitted	
MAF calculated by Designer	1.008
MAF by DTE for PE/PS	**1.000**

PRODUCER: DATE:

DTE SIGNATURE: DATE:

DTE Notes:
DMF reference history:
Producer Notes:

Figure 9-2. Design Mix Formula

TD-452 State Form 36667 (R3/3-95)

COPIES TO:
DISTRICT TESTING ENGINEER
FILE

INDIANA DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS

RANDOM SAMPLING FOR MIX ANALYSIS

Contract No. R-20396 LOT No. 4

District Greenfield Mixture 19.0 mm Intermediate

DATE SAMPLED: SUBLOT 1 6/9/01 SUBLOT 2 6/9/01 SUBLOT 3 6/10/01 SUBLOT 4 6/10/01

SUBLOT NO.	SUBLOT TONS	RANDOM NO.	RANDOM TON	LOT TON TO BE SAMPLED		PAVING WIDTH	RANDOM NO.	TRANS. LOC.	LENGTH OF LOAD	RANDOM NO.	RANDOM DIST.	STARTING STA.*	RANDOM STATION
	A	B	A x B = C	D	C + D	E	F	E x F	G	H	G x H = I	J	I + J
1	600			0									N.B. Passing
	1000	.123	123	0	123	12	.100	1.2 (1)	136	.259	35	10+50	10+85
2	600			625									N.P. Passing
	1000	.116	116	1000	1116	12	.890	10.7 (11)	136	.317	43	76+90	77+33
3	600			1250									N.B. Passing
	1000	.836	836	2000	2836	12	.523	6.3 (6)	136	.665	90	194+00	194+90
4	600			1875									N.B. Passing
	1000	.636	636	3000	3636	12	.928	11.1 (11)	136	.404	55	247+20	247+75

* *STATION OF PAVER WHEN TRUCK CONTAINING RANDOM TON BEGINS UNLOADING.*

$$\textit{Length of Load} = \frac{\text{Load Weight (tons)}}{\text{Avg. Planned Quantity (lb./sq. yd.)} \times \text{Width of Paving (ft.)}} \times 18000$$

(Nearest Foot)

Figure 9-3. Random Sampling for Mix

The length the truck places is multiplied by the first random number to obtain a longitudinal distance. This distance is measured from the location of the paver when the truck containing the random ton begins unloading into the paver or material transfer device. The transverse test site location is determined by multiplying the width of pavement by the second random number and rounding to the nearest whole ft. This distance is measured from the right edge of pavement when looking in the direction of increasing station numbers. If the transverse location is less than 1 ft from either edge of pavement, at a location where the course thickness is less than 2.0 times the maximum particle size, or within the width of the roller drum used to form shoulder corrugations, then another random location is selected to obtain an acceptable sampling location. The following example indicates how these random locations are determined.

Example:

Width of Pavement	=	12 ft
Load Weight	=	20 t
Mixture	=	9.5 mm Surface
Planned Quantity	=	110 lb/yd^2
Ending Station of Paver of Previous Load	=	158+00
Random Numbers	=	256, .561

Test Site Station

$$\text{Length of Load} = \frac{20}{110 \times 12} \times 18000 = 273 \text{ ft}$$

Longitudinal Distance = 273 x .256 = 70 ft

Random Station = (158+00) + 70 = 158+70

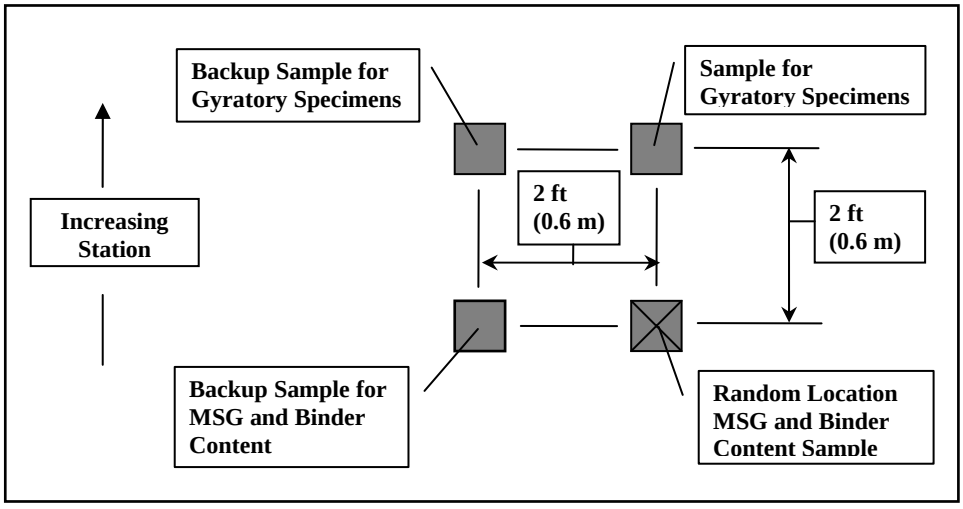
Transverse Distance

Distance = 12 x .561 = 6.7 ft (say 7 ft)

For contracts controlled by volumetrics for QC/QA HMA (**401)**, several samples are required. The first plate sample location is determined by the random sampling procedure and this material is used for the maximum specific gravity and binder content samples. A second plate sample is placed longitudinally 2 ft upstation from the first plate at the same transverse offset. This sample is used for the gyratory specimens.

If an appeal by the Producer of the INDOT test results is accepted, backup samples are tested. These samples are obtained at the same time as the acceptance samples. The backup sample plate for the maximum specific gravity and binder content is placed transversely 2 ft from the first plate towards the center of the mat. The backup sample for the gyratory specimens is placed transversely 2 ft from the second plate towards the center of the mat.

The following diagram indicates an example of an arrangement of the plate samples when additional samples are required for QC/QA HMA:



Example:

Width of Pavement	= 12 ft
Load Weight	= 20 t
Mixture	= 9.5 mm Surface
Planned Quantity	= 110 lb/yd^2
Ending Station of Paver of Previous Load	= 158+00
Random Numbers	= .256, .561

Test Site Station

$$\text{Length of Load} = \frac{20}{110 \times 12} \times 18000 = 273 \text{ ft}$$

Longitudinal Distance = 273 x .256 = 70 ft
Random Station = (158+00) + 70 = 158+70

Transverse Distance
Distance = 12 x .561 = 6.7 ft (say 7 ft)

MSG and Binder Content Sample

Random Location = 158 + 70
Transverse Distance = 7 ft

Gyratory Specimens Sample

Random Location = (158 + 70) + 2 ft
= 158 + 72
Transverse Distance = 7 ft

Backup Sample for MSG and Binder Content

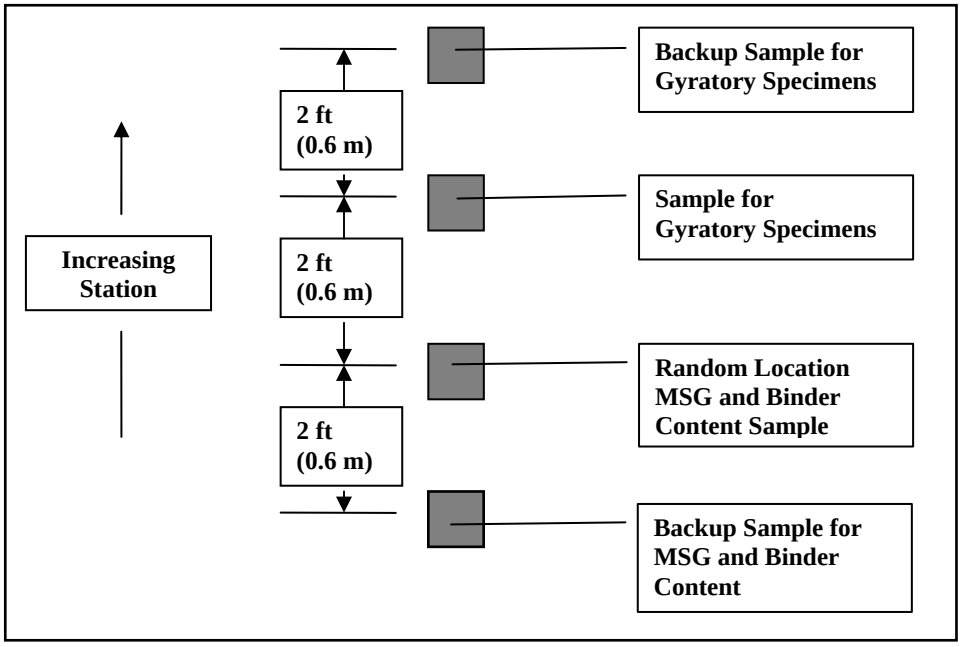
Random Location = 158 + 70
Transverse Distance = 7-2 = 5 ft

Backup Sample for Gyratory Specimens

Random Location = (158 + 70) + 2 ft
= 158 + 72
Transverse Distance = 7-2 = 5 ft

When the pavement width is 4 ft or less, the samples are obtained from the center of the course and at least 1 ft from the edge of the course. The backup sample plate for the maximum specific gravity and binder content is placed 2 ft back station from the first plate in the center of the course. The backup sample for the gyratory specimens is placed 2 ft ahead station from the second plate in the center of the course.

The following diagram indicates an example of an arrangement of the plate samples when additional samples are required for QC/QA HMA and the width of the pavement course is 4ft or less:



Example:

Width of Pavement	= 4 ft
Load Weight	= 20 t
Mixture	= 9.5 mm Surface
Planned Quantity	= 110 lb/yd^2
Ending Station of Paver of Previous Load	= 158+00
Random Numbers	= .256, .561

Test Site Station

$$\text{Length of Load} = \frac{20}{110 \times 4} \times 18000 = 818 \text{ ft}$$

Longitudinal Distance = 818 x .256 = 209 ft

Random Station = (158+00) + 209 = 160+09

Transverse Distance

Distance = 4/2 = 2 ft

MSG and Binder Content Sample

Random Location = 160 + 09
Transverse Distance = 2 ft

Gyratory Specimens Sample

Random Location = (160 + 09) + 2 ft
= 160 + 11
Transverse Distance = 2 ft

Backup Sample for MSG and Binder Content

Random Location = (160 + 09) – 02
= 160 + 07
Transverse Distance = 2 ft

Backup Sample for Gyratory Specimens

Random Location = (160 + 11) + 2 ft
= 160 + 13
Transverse Distance = 2 ft

The size of the plate used to obtain a sample is dependent on the test(s) conducted on the material. The following minimum sample weights are required:

Mixture Designation	Minimum Weights (g)	
	MSG and Binder Content	Gyratory Specimens
4.75 mm	1200	11000
9.5 mm	3000	11000
12.5 mm	4000	11000
19.0 mm, OG 19.0 mm	5500	11000
25.0 mm, OG 25.0 mm	7000	11000

Figure 5-4 indicates the approximate weights that may be obtained for various sizes of plates and lift thicknesses that are placed.

Figure 5-5 indicates the approximate weights that may be obtained for various sizes of molds and lift thicknesses when a mold is used with the plate for obtaining a sample.

Approximate Sample Yield for Various Lift Thickness and Plate Sizes								
Lift Thickness (inches)	**Lay Rate (lb/syd)**	**Plate Size, inches**						
		8	**9**	**10**	**11**	**12**	**14**	**16**
		Sample Weight (g)						
1.25	137.5	3100	3900	4800	5900	7000	9500	12400
1.5	165	3700	4700	5800	7000	8400	11400	14900
1.75	192.5	4300	5500	6800	8200	9800	13300	17300
2.0	220	5000	6300	7700	9400	11100	15200	19800
2.25	247.5	5600	7100	8700	10500	12500	17100	22300
2.5	275	6200	7800	9700	11700	13900	19000	27800
2.75	302.5	6800	8600	10600	12900	15300	20900	27300
3.0	330	7400	9400	11600	14100	16700	22800	29700
3.25	357.5	8100	10200	12600	15200	18100	24700	32200
3.5	385	8700	11000	13500	16400	19500	26600	34700
3.75	412.5	9300	11800	14500	17600	20900	28500	37200
4.0	440	9900	12500	15500	18700	22300	30300	39600
4.25	467.5	10500	13300	16400	19800	23600	32100	41900
4.5	495	11100	14000	17300	21000	25000	34000	44400
4.75	522.5	11700	14800	18300	22100	26400	35900	46900
5.0	550	12300	15600	19300	23300	27700	37800	49300
5.25	577.5	12900	16400	20200	24500	29100	39700	51800
5.5	605	13600	17200	21200	25600	30500	41500	54300
5.75	632.5	14200	17900	22200	26800	31900	43400	56700
6.0	660	14800	18700	23100	28000	33300	45300	59200

Figure 9-4. Approximate Sample Yield for Various Lift Thickness and Plate Sizes

Approximate Sample Yield for Various Lift Thicknesses and Mold Sizes						
Lift Thickness (inches)	**Lay Rate (lb/yd²)**	**Mold Size, inches**				
		8	**10**	**12**	**14**	**16**
		Sample Weight (g)				
1.25	137.5	2400	3800	5400	7400	9700
1.5	165	2900	4500	6500	8900	11600
1.75	192.5	3400	5300	7600	10400	13600
2.0	220	3900	6100	8700	11900	15500
2.25	247.5	4400	6800	9800	13300	17400
2.5	275	4800	7600	10900	14800	19400
2.75	302.5	5300	8300	12000	16300	21300
3.0	330	5800	9100	13100	17800	23200
3.25	357.5	6300	9800	14200	19300	25200
3.5	385	6800	10600	15300	20800	27100
3.75	412.5	7300	11300	16300	22200	29100
4.0	440	7700	12100	17400	23700	31000
4.25	467.5	8200	12900	18500	25200	32900
4.5	495	8700	13600	19600	26700	34900
4.75	522.5	9200	14400	20700	28200	36800
5.0	550	9700	15100	21800	29700	38700
5.25	577.5	10200	15900	22900	31100	40700
5.5	605	10700	16600	24000	32600	42600
5.75	632.5	11100	17400	25100	34100	44500
6.0	660	11600	18200	26100	35600	46500

Figure 9-5. Approximate Sample Yield for Various Lift Thicknesses and Mold Sizes

ADJUSTMENT PERIOD -- QC/QA HMA and SMA

The Producer is allowed an adjustment period for each mix design in which the mix design is verified and changes may be made in the DMF, if necessary. A job mix formula (JMF) is submitted for approval to the Engineer upon completion of the adjustment period. The adjustment period is from the beginning of production and extending until 4000 t of base or intermediate QC/QA HMA, or 2400 t of surface QC/QA HMA or SMA has been produced for each mix design. A reduced adjustment period is allowed. If production extends into the next construction season, another adjustment period is allowed.

MIXTURE ACCEPTANCE

QC/QA HMA

Acceptance of QC/QA HMA mixtures for binder content, VMA at N_{des}, and air voids at N_{des} for each lot is based on tests conducted by INDOT. INDOT randomly select the location(s) within each sublot for sampling in accordance with the **ITM 802.**

Samples from the pavement are obtained from each sublot in accordance with **ITM 580**. The test results for each sublot are required to be within the tolerances from the JMF as shown in the table as follows:

ACCEPTANCE TOLERANCES	
MIXTURE PROPERTIES	**TOLERANCES FROM JMF**
DENSE GRADED	
Air Voids	JMF ± 1.0%
Binder Content	JMF ± 0.5%
VMA	JMF ± 1.0%
OPEN GRADED	
Air Voids *	JMF ± 3.0%
Binder Content	JMF ± 0.5%

* Gmb is determined in accordance with **ASTM D 6752**

A binder draindown test in accordance with **AASHTO T 305** for open graded mixtures is requird once per lot and may exceed 0.50 %.

The acceptance test results for each sublot are available after the sublot and the testing are complete.

HMA

Acceptance of HMA mixtures is done on the basis of a Type D certification submitted by the Producer to the Project Engineer on a contract. An example of this form is shown in Figure 5-6. The certification is required to be submitted with the first truck of each type of mixture each day. If no test results are available, the Producer indicates on the form that test results are required to be obtained within the first 250 tons and each subsequent 1000 tons for base and intermediate mixtures, and the first 250 tons and each subsequent 600 tons for surface mixtures.

SMA

Acceptance of SMA mixtures for binder content and gradation for each sublot is based on tests conducted by INDOT. The sample locations are determined by INDOT in accordance with **ITM 802** and samples are obtained from each sublot in accordance with **ITM 580.**

Test results for binder content, and gradation may not exceed the allowable tolerances of Section **401.09**. A binder draindown test in accordance with **AASHTO T 305** is required once per lot and may not exceed 0.30 %. The acceptance test results for each sublot are available after the sublot and the testing are complete.

INDIANA DEPARTMENT OF TRANSPORTATION
HOT MIX ASPHALT (HMA) CERTIFICATION

CONTRACT NUMBER ____RS-30000_____ DATE__5/3/07_____

CERTIFIED HMA PRODUCER _____J. Wooden Construction_____

CERTIFIED HMA PLANT NUMBER ____3550___ DMF/JMF NUMBER ___0310075___

PG BINDER SOURCE _____7199_____ PG BINDER GRADE____PG 64-22_____

MIXTURE TYPE AND SIZE _____HMA Surface, 9.5 mm, Type A_____

DESIGN ESAL _____200,000_____

Air Voids __4.0__ (from DMF/JMF) Binder Content ___5.5__ (from DMF/JMF)

This is to certify that the test results for Air Voids and Binder Content represent the HMA mixture supplied to this contract.

Air Voids __4.3_ (± 1.5 % from DMF/JMF) Binder Content __5.7_ (± 0.7 % from DMF/JMF)

* [ ] Test results are not available for submittal. A production sample shall be taken within the first 250 t (250 Mg) and each subsequent 1000 t (1000 Mg) for base and intermediate mixtures and each subsequent 600 t (600 Mg) for surface mixtures.

* _✓_ If Applicable

_____
Signature of HMA Producer Official

_____
Title of Official

FOR PE/PS USE ONLY

PAY ITEM(S) _____ BASIS FOR USE NO. C999998

SPECIFICATION REFERENCE

__ 304.04 - Patching	__ 402.07(c) - Temporary HMA	__ 610.02 - Approaches
__ 304.05 - Widening	__ 503.03(e) - Terminal Joints	__ 611.02 - Crossovers
__ 402.04 - HMA Pavements	__ 507.05(b) - Partial Depth Patching	__ 718.04 - Underdrains
__ 402.07(a) - Rumble Strips	__ 604.07(c) – Sidewalk	__ 801.11- Temp. Cross
__ 402.07(b) - Wedge & Leveling	__ 605.07(c) - Curbing	

Figure 9-6. HMA Certification

PAY FACTORS -- QC/QA HMA

After the tests are conducted, the test data is evaluated for compliance with the Specifications. CAA and temperature tests are taken in accordance with standard procedures and recorded. Lot numbers begin with number 1 for each type of mixture and are continuous for the entire contract regardless of the number of adjustment periods for that type of mixture.

When the required tests for one sublot are completed, the difference between the test values and the required value on the JMF is determined and pay factors calculated. For mixtures produced during the adjustment period, pay factors based on the JMF are used. A composite pay factor for each sublot is determined for the binder content, air voids @ N_{des}, VMA @ N_{des}, and density of the mixture as follows:

$$SCPF = 0.20(PF_{BINDER}) + 0.35(PF_{VOIDS}) + 0.10(PF_{VMA}) + 0.35(PF_{DENSITY})$$

where:

SCPF	=	Sublot Composite Pay Factor for Mixture and Density
PF_{BINDER}	=	Sublot Pay Factor for Binder Content
PF_{VOIDS}	=	Sublot Pay Factor for Air Voids at N_{des}
PF_{VMA}	=	Sublot Pay Factor for VMA at N_{des}
$PF_{DENSITY}$	=	Sublot Pay Factor for Density

If the SCPF for a sublot is less than 0.85, the pavement is evaluated by INDOT. If the Contractor is not required to remove the mixture, quality assurance adjustments of the sublot are assessed or other corrective actions taken as determined by INDOT.

MIXTURE

Sublot test results for mixture properties are assigned pay factors in accordance with the following:

BINDER CONTENT		
DENSE GRADED Deviation from JMF (±%)	**OPEN GRADED Deviation from JMF (±%)**	**PAY FACTOR**
≤ 0.2	≤ 0.2	1.05
0.3	0.3	1.04
0.4	0.4	1.02
0.5	0.5	1.00
0.6	0.6	0.90
0.7	0.7	0.80
0.8	0.8	0.60
0.9	0.9	0.30
1.0	1.0	0.00
> 1.0	> 1.0	Submit to the Office of Materials Management*

***** Test results are considered and adjudicated as a failed material in accordance with normal INDOT practice as listed in 105.03.

AIR VOIDS		
DENSE GRADED Deviation from JMF (±%)	**OPEN GRADED Deviation from JMF (±%)**	**PAY FACTOR**
≤ 0.5	≤ 1.0	1.05
> 0.5 and ≤ 1.0	> 1.0 and ≤ 3.0	1.00
1.1	3.1	0.98
1.2	3.2	0.96
1.3	3.3	0.94
1.4	3.4	0.92
1.5	3.5	0.90
1.6	3.6	0.84
1.7	3.7	0.78
1.8	3.8	0.72
1.9	3.9	0.66
2.0	4.0	0.60
> 2.0	> 4.0	Submit to the Office of Materials Management*

***** Test results are considered and adjudicated as a failed material in accordance with normal INDOT practice as listed in 105.03.

VMA		
DENSE GRADED Deviation from JMF (±%)	**OPEN GRADED Deviation from JMF (±%)**	**PAY FACTOR**
≤ 0.5		1.05
> 0.5 and ≤ 1.0	All	1.00
> 1.0 and ≤ 1.5		0.90
> 1.5 and ≤ 2.0		0.70
> 2.0 and ≤ 2.5		0.30
> 2.5		Submit to the Office of Materoals Management*

* Test results are considered and adjudicated as a failed material in accordance with normal INDOT practice as listed in 105.03.

DENSITY

Sublot test results for density are assigned pay factors in accordance with the following:

DENSITY		
Percentages based on % MSG	**Pay Factors – Percent**	
Dense Graded	Open Graded	
≥ 97.0		Submitted to the Office of Materials Management*
95.6 - 96.9		1.05 - 0.01 for each 0.1% above 95.5
94.0 - 95.5		1.05
93.1 - 93.9		1.00 + 0.005 for each 0.1% above 93.0
92.0 - 93.0	84.0	1.00
91.0 - 91.9		1.00 - 0.005 for each 0.1% below 92.0
90.0 - 90.9		0.95 - 0.010 for each 0.1% below 91.0
89.0 - 89.9		0.85 - 0.030 for each 0.1% below 90.0
≤ 88.9		Submitted to the Office of Materials Management*

* Test results are considered and adjudicated as a failed material in accordance with normal INDOT practice as listed in 105.03.

Figure 5-7 indicates the density pay factors required for the % Maximum Specific Gravity of the cores.

DENSITY -- DENSE GRADED							
% MSG	**Pay Factor**	**% MSG**	**Pay Factor**	**% MSG**	**Pay Factor**	**% MSG**	**Pay Factor**
≥97.0	*	94.9	1.05	92.8	1.00	90.7	0.92
96.9	0.91	94.8	1.05	92.7	1.00	90.6	0.91
96.8	0.92	94.7	1.05	92.6	1.00	90.5	0.90
96.7	0.93	94.6	1.05	92.5	1.00	90.4	0.89
96.6	0.94	94.5	1.05	92.4	1.00	90.3	0.88
96.5	0.95	94.4	1.05	92.3	1.00	90.2	0.87
96.4	0.96	94.3	1.05	92.2	1.00	90.1	0.86
96.3	0.97	94.2	1.05	92.1	1.00	90.0	0.85
96.2	0.98	94.1	1.05	92.0	1.00	89.9	0.82
96.1	0.99	94.0	1.05	91.9	1.00	89.8	0.79
96.0	1.00	93.9	1.05	91.8	0.99	89.7	0.76
95.9	1.01	93.8	1.04	91.7	0.99	89.6	0.73
95.8	1.02	93.7	1.04	91.6	0.98	89.5	0.70
95.7	1.03	93.6	1.03	91.5	0.98	89.4	0.67
95.6	1.04	93.5	1.03	91.4	0.97	89.3	0.64
95.5	1.05	93.4	1.02	91.3	0.97	89.2	0.61
95.4	1.05	93.3	1.02	91.2	0.96	89.1	0.58
95.3	1.05	93.2	1.01	91.1	0.96	89.0	0.55
95.2	1.05	93.1	1.01	91.0	0.95	88.9	*
95.1	1.05	93.0	1.00	90.9	0.94		
95.0	1.05	92.9	1.00	90.8	0.93		
DENSITY -- OPEN GRADED							
84.0 -- 1.00							

* Requires submittal to Office of Materials Management for Failed Material Investigation

Figure 9-7. Density Pay Factors

The following example indicates how Quality Assurance Adjustments are determined:

Example:

25.0 mm Base

Sublot 1 = 1000 tons
Sublot 2 = 1000 tons
Sublot 3 = 1000 tons
Sublot 4 = 1000 tons

Unit Price = $28.00/ton

MAF = 1.000

JMF % Binder = 4.2 %
Air Voids = 4.0 %
VMA = 12.5 %

	Sublot 1	Sublot 2	Sublot 3	Sublot 4
% Binder	4.5	4.6	4.8	4.2
Air Voids	3.8	3.7	3.2	4.7
VMA	12.2	12.1	11.6	13.4
Density (%MSG)	91.1	90.7	89.9	92.9

Deviations for JMF % Binder, Air Voids, and VMA:

	Sublot 1	Sublot 2	Sublot 3	Sublot 4
% Binder	0.3	0.4	0.6	0.2
Air Voids	0.2	0.3	0.8	0.7
VMA	0.3	0.4	0.9	0.9

Using the pay factor charts, the following values are obtained:

	Sublot 1	Sublot 2	Sublot 3	Sublot 4
% Binder	1.04	1.02	0.90	1.05
Air Voids	1.05	1.05	1.00	1.00
VMA	1.05	1.05	1.00	1.00
Density (%MSG)	0.96	0.92	0.82	1.00

Calculations to determine the Quality Assurance Adjustment are indicated in Figure 5-8.

INDIANA DEPARTMENT OF TRANSPORTATION

HOT MIX ASPHALT ANALYSIS FOR QUALITY ASSURANCE

CONTRACT NO. _____ PLANT NO. _____ LOT NO. _____ DATE _____

MIXTURE _____ DMF/JMF NO. _____

Mixture & Density	SUBLOT 1			SUBLOT 2			SUBLOT 3			SUBLOT 4		
	Pay Factor	Mult		Pay Factor	Mult		Pay Factor	Mult.		Pay Factor	Mult.	
% Binder	1.04	0.20	0.2080	1.02	0.20	0.2040	0.90	0.20	0.1800	1.05	0.20	0.2100
Air Voids	1.05	0.35	0.3675	1.05	0.35	0.3675	1.00	0.35	0.3500	1.00	0.35	0.3500
VMA	1.05	0.10	0.1050	1.05	0.10	0.1050	1.00	0.10	0.1000	1.00	0.10	0.1000
Density	0.96	0.35	0.3360	0.92	0.35	0.3220	0.82	0.35	0.2870	1.00	0.35	0.3500
SCPF			1.02			1.00			0.92			1.01

* Requires submittal to the Materials and Tests Division for Failed Material Investigation

QUALITY ASSURANCE ADJUSTMENTS							
Sublot 1 Quantity L (tons)	Sublot 1 Adjustment ($)	Sublot 2 Quantity L (tons)	Sublot 2 Adjustment ($)	Sublot 3 Quantity L (tons)	Sublot 3 Adjustment ($)	Sublot 4 Quantity L (tons)	Sublot 4 Adjustment ($)
1000	+560	1000	0	1000	-2240	1000	+280

U = Unit Price for Material, $/Ton

Quality Assurance Adjustment = L x U x (SCPF – 1.00) / MAF

Figure 9-8. Quality Assurance Adjustment

MIX APPEAL -- QC/QA HMA

If the Producer does not agree with the acceptance test results, a request may be submitted in writing that additional samples be tested. The written request is required to include the Producer's test results and be made within seven calendar days of receipt of the written results of the HMA tests for that lot. The appeal is not accepted if the Producer has not conducted any tests that indicate a higher Pay Factor than was determined from the test results by INDOT.

Additional tests for the appeal may be requested for the maximum specific gravity, bulk specific gravity of the gyratory specimens, binder content, or bulk specific gravity of the density cores. One or more of these tests may be requested for the sublot or entire lot. Upon approval of the appeal, the backup samples are tested as follows:

1) Maximum Specific Gravity -- The sample is dried in accordance with **ITM 572** and tested in accordance with **AASHTO T 209**, Section 9.5.1.

2) Bulk Specific Gravity of the Gyratory Specimens -- New gyratory specimens are prepared and tested in accordance with **AASHTO T 312**.

3) Binder Content -- The binder content is tested in accordance with the test method that was used for acceptance.

4) Bulk Specific Gravity of the Density Core -- Additional cores are taken within seven calendar days unless otherwise directed. The core locations are determined by adding 1.0 ft longitudinally of the cores tested for acceptance using the same transverse offset. The cores are tested in accordance with **AASHTO T 166**.

The appeal results replace all previous test result(s) for acceptance of the mixture properties and density.

ADJUSTMENT QUANTITY -- QC/QA HMA

The pay factors are used to calculate a quality assurance adjustment quantity (q) for the sublot. The adjustment for mixture properties and density is calculated as follows:

$$q = L \times U \times (SCPF - 1.00)/MAF$$

where:

q = quality assurance adjustment for the sublot
L = sublot quantity
U = unit price for the material, $/Ton
SCPF = sublot composite pay factor

The total quality assurance adjustments are calculated as follows:

$$Q = Qs + (\Sigma\, q)$$

where:

Q = total quality assurance adjustment
Qs = quality assurance adjustment for smoothness as calculated in Section **401.19(c)**
q = sublot quality assurance adjustment

ADJUSTMENT QUANTITY -- SMA

The adjustment points are used to calculate a quality assurance adjustment quantity (q) for the sublot. The adjustment for mixture properties and density is calculated as follows:

$$q = (L \times U \times P/100)/MAF$$

where:

q = quality assurance adjustment quantity
L = lot quantity
U = unit price for material, $/TON
P = total adjustment points

The total quality assurance adjustments are to be calculated as follows:

$$Q = Q_s + 3\,(q_m + q_d)$$

where:

Q = total quality assurance adjustment quantity
Q_s = quality assurance adjustment for smoothness as calculated in Section **401.19(c)**
q_m = lot adjustments for mixtures
q_d = lot adjustments for density

MIXTURE ADJUSTMENT FACTOR

A Mixture Adjustment Factor (MAF) is used to adjust the mixture planned quantity and lay rate prior to paving operations, and the pay quantity upon completion of production of the mixture. The MAF is calculated by dividing the maximum specific gravity (G_{mm}) from the mixture design by the following values:

Mixture		
9.5 mm	--	2.465
12.5 mm	--	2.500
19.0 mm	--	2.500
25.0 mm	--	2.500

If the calculated MAF is equal to or greater than 0.980 and equal to or less than 1.020, the MAF value is considered to be 1.000. If the calculated MAF is less than 0.980, then 0.020 is added to the value. If the calculated MAF is greater than 1.020, 0.020 is subtracted from the value. The planned quantity and lay rate are adjusted by multiplying by the MAF. The accepted quantity for payment is adjusted by dividing by the MAF.

Example:

Mixture	=	9.5 mm Surface
Planned Quantity	=	9750.00 tons
Placed Quantity	=	9500.00 tons
Mix Design G_{mm}	=	2.360
Lay Rate	=	165 lb/yd^2

$$MAF = \frac{2.360}{2.465} = 0.957$$

$$MAF = 0.957 + 0.020 = 0.977$$

Adjusted Planned Quantity = 0.977 x 9750.00 = 9525.75 tons

Adjusted Lay Rate = 0.977 x 165 lb/yd^2 = 161 lb/yd^2

$$\text{Adjusted Pay Quantity} = \frac{9500.00}{0.977} = 9723.64 \text{ tons}$$

The MAF does not apply to open graded mixtures.